British Journal of Urology (1990), **66**, 1–5
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0007-1331/90/0066-0001/$10.00

The Changing Practice of Percutaneous Stone Surgery. Review of 1000 Cases 1981–1988

D. J. JONES, G. L. RUSSELL, M. J. KELLETT and J. E. A. WICKHAM

St Paul's Hospital and Institute of Urology, London

Summary—A review was carried out on 1000 cases of percutaneous nephrolithotomy (PCNL), Group 1 (500), 1981–1985, being compared with Group 2 (500), 1985–1988. Previous renal surgery had been performed in 17.4% of patients in Group 1 and 36% in Group 2. There were 17.2% complicated patients in Group 1 and 51% in Group 2. The stone burden included 30.2% multiple, partial staghorn and staghorn calculi in Group 1 and 47.2% in Group 2. The use of *in situ* stone disintegration increased from 22.2% in Group 1 to 73.4% in Group 2 and nephrostomy drainage was necessary in 29.6% compared with 75%. Post-operative complications increased from 13.6 to 24%. Stone-free rates decreased from 92 to 51%, but the addition of other methods of treatment and the inclusion of patients with stone fragments of 2 mm or less increased these figures to 98% in Group 1 and 83% in Group 2.

More complicated patients with complex stones are now being referred for PCNL. These patients require multiple treatments, including extracorporeal shock wave lithotripsy (ESWL) and percutaneous surgery, in combination with other endoscopic and radiological procedures.

Percutaneous removal of a renal stone was first reported by Rupel and Brown (1941). Brantley and Shirley (1974) performed stone extraction using a Dormia basket for retained renal stones in the post-operative period and Fernstrom and Johanson (1976) described the removal of renal stones in 3 patients under radiological control via a nephrostomy tube. Following these early descriptions, urologists in England and West Germany developed the technique of percutaneous nephroscopy and stone extraction under direct vision (Alken *et al.*, 1981; Wickham and Kellett, 1981a and b). In early series of patients undergoing this technique, the success rates ranged from 71 to 91% (Whitfield, 1983; Wickham *et al.*, 1983a and b; Clayman *et al.*, 1984; Whitfield and Mills, 1985).

A success rate of 98.3% was subsequently reported from the Mayo Clinic (Segura *et al.*, 1985) in a series of 1000 patients, although only 805 of these patients had renal calculi. The majority of stones reported in these series were small and suitable for simple extraction. Lee *et al.* (1986) reported a success rate for such simple stones of 98% and for staghorn calculi 87%, in a series of 500 patients. Payne *et al.* (1985) reviewed 450 patients undergoing PCNL with successful removal in 92% at the first procedure, rising to 98% with subsequent PCNL.

More recently, workers have compared the results of ESWL and PCNL or a combination of these treatments in an attempt to define efficacy, cost and complication rates (Charig *et al.*, 1986; Dickinson *et al.*, 1986; Lingeman *et al.*, 1987). Whilst there is no strong consensus of opinion regarding the best treatment for calculi, there is general agreement that for difficult stones a combination of treatments is necessary. There has, however, been a suggestion recently that PCNL may be preferable to ESWL and that investment in lithotripsy facilities may be inadvisable (Mays *et al.*, 1988).

In view of the fact that many of the high success rates and low complication rates reported from

Accepted for publication 6 December 1989

various PCNL series were based on simple stones and that the expectations of patients and referring doctors may thus be falsely raised by these figures, we reviewed 1000 patients who had undergone PCNL to see whether the patients being referred, their stone burden, the success and complication rates had changed, at a time when ESWL was rapidly developing and possibly treating the more simple stones.

Patients and Methods

The study group comprised 1000 patients undergoing PCNL at St Paul's Hospital between 1981 and 1988. They were divided into 2 groups of 500: Group 1 patients underwent PCNL between 1981 and 1985 and Group 2 patients between 1985 and 1988. The technique of PCNL has been well described (Alken *et al.*, 1981; Wickham and Kellett, 1981a and b) and the early patients in Group 1 had a 2-stage procedure and stone extraction via a Dormia basket. The remaining patients in Group 1 and all patients in Group 2 had a single-stage procedure, with simple stones being extracted using alligator or triradiate forceps and larger stones being disintegrated by means of ultrasound or electrohydraulic lithotripsy (Miller *et al.*, 1983, 1984a and b; Wickham *et al.*, 1984). All patients received prophylactic antibiotics and PCNL was routinely performed under general anaesthesia. Retrograde placement of a ureteric catheter for introduction of contrast media or to flush a ureteric stone was used routinely when possible (Kellett *et al.*, 1985).

Results

The characteristics of the 2 groups are shown in Table 1, revealing a preponderance of males and left-sided stones. The mean age in Group 2 was greater by 5 years (43.2 versus 48.4 years). The stone burden is shown in Table 2, with an increase in patients with large, multiple or complex stones in Group 2. The number of patients with complicated problems either of a renal or general medical nature has also increased and the details are shown in Table 3. Serious medical conditions included chronic renal failure, abnormal clotting disorders, skeletal deformities, severe respiratory problems, diabetes, ischaemic heart disease, leukaemia, neurological disorders and there were 3 patients who were Jehovah's Witnesses. The technique of stone removal evolved during the period of this study with increasing radiological and endourological expertise and the use of more sophisticated purpose-designed instruments (Miller and Wickham, 1983; Miller *et al.*, 1984a and b). The 2-stage technique for PCNL was used in 183 patients (33.6%) in Group 1 and then abandoned.

Table 1 Age, Sex, Stone Distribution and Previous Surgery

	Group 1 (%) (n=500)	*Group 2 (%) (n=500)*
Male	287 (57.6)	273 (54.4)
Female	213 (42.4)	227 (45.6)
Left-sided	272 (54.5)	281 (56)
Right-sided	228 (45.5)	211 (44)
Age range (years) (mean)	5–89 (43.2)	13–83 (48.4)
Previous renal surgery	87 (17.4%)	180 (36%)

Table 2 Stone Burden

Stones	*Group 1 (%) (n=500)*	*Group 2 (%) (n=500)*
Solitary < 10 mm	238 (47.6)	132 (26.4)
Solitary > 10 mm	111 (24.2)	132 (26.4)
Multiple	68 (13.6)	91 (18.2)
Partial staghorn	32 (6.4)	46 (9.2)
Staghorn	51 (10.2)	99 (19.8)

Table 3 Complicated Cases

Complications	*Group 1 (n=86)*	*Group 2 (n=255)*
Solitary	19	34
Horseshoe	3	12
Transplants	1	5
Stoma	14	33
Paraplegia	2	12
Gross obesity	3	14
Serious medical conditions	44	145

The details of operative technique for access and stone removal are shown in Table 4. Per-operative complications were experienced in 138 patients (27.6%) in Group 1 and 89 (17.8%) in Group 2. Significant perforation of the renal pelvis or calices was seen in 74 patients (14.8%) in Group 1 but in only 20 (4%) in Group 2. The incidence of per-operative bleeding sufficient to prolong the surgery or cause it to be abandoned remained unchanged, occurring in 64 patients (12.8%) in Group 1 and 58 (11.6%) in Group 2. Other complications such as equipment failure, stones being flushed down the ureter, failure of a ureteric "push" (Kellet *et al.*, 1985), Amplatz tube misplacement and difficulties due to skeletal deformities were similar in both

groups, with 27 (5.4%) in Group 1 and 25 (5%) in Group 2. Post-operative complications increased, occurring in 68 patients (13.6%) in Group 1 and 120 (24%) in Group 2. The details of these complications are shown in Table 5. Sepsis was defined as the presence of a significant pyrexia necessitating the use of parenteral antibiotics. Transfusion requirements were greater in Group 2, but the majority of patients transfused required 2 to 3 units only. Six patients required massive transfusion (8–14 units) and embolisation under radiological control was successfully carried out in all 6. Of the 3 deaths in Group 1, 2 were due to myocardial infarction and 1 patient died of overwhelming sepsis in the immediate post-operative period. In Group 2, 3 of the deaths were from myocardial infarction and the remaining patient, an 82-year-old female with bilateral staghorn calculi and chronic renal failure, died of bronchopneumonia.

More than 1 PCNL procedure was necessary in 28 patients (5.6%) in Group 1 (27 patients (2 procedures), 1 patient (3)) and 80 patients (16%) in Group 2 (71 patients (2), 7 patients (3), 2 patients (4)). Open surgery was subsequently required in 32 patients in Group 1 (nephrectomy (1), nephrolithotomy (11), pyelolithotomy (9), ureterolithotomy (11)), almost all in the earlier cases. Thirteen patients in Group 2 required open surgery: 3 underwent nephrectomy and 1 a partial nephrectomy for what were deemed to be poorly or non-functioning kidneys still containing stones after PCNL. In addition there were 2 nephrolithomies, 2 pyelolithotomies, 1 pyeloplasty, 2 ureterolithotomies and 1 ureteric stricturoplasty. The success rates, as defined by the patients being stone-free or having fragments of 2 mm or less, are shown in Table 6. Whereas 92% of patients were rendered stone-free in Group 1 by PCNL alone, only 51% of patients in Group 2 had complete stone clearance. The addition of other methods of treatment in this group (ESWL (139 patients), ureteroscopy (35), open surgery (11)) increased the stone-free rate to 59%, with a further 24% having fragments of 2 mm or less. Thus with a combination of all treatments, 98% in Group 1 and 83% in Group 2 eventually became stone-free or had fragments of 2 mm or less.

Table 4 Per-operative Techniques for Access and Stone Removal

Techniques	*Group 1*	*Group 2*
Two-stage	183	0
Failed access	73	25
>1 puncture	32	107
Dormia basket	68	0
Alligator/triradiate forceps	321	133
US/EHL disintegration	111	367
Nephrostomy drainage	148	375

Table 5 Post-operative Complications

	Group 1	*Group 2*
Patients	68 (13.6%)	120 (24%)
Sepsis	28	47
Transfusion	29	55
Ureteric obstruction	21	10
Embolisation	2	4
Others (Chest infection, pain, gross haematuria, urethral stricture, ureteric stricture, pulmonary oedema, acute renal failure)	8	26
Deaths	3	4

Table 6 Success rates from PCNL alone and PCNL and other Procedures (ESWL, URS and laser, open surgery)

	Group 1 (%)	*Group 2 (%)*
After PCNL only		
Stone-free	460 } 466 (93.2)	255 } 328 (65.8)
2 mm fragments or less	6 }	73 }
>2 mm fragments	34 (6.8)	172 (34.2)
After PCNL ± other procedure		
Stone-free	487 } 493 (98.6)	295 } 415 (83)
2 mm fragments or less	6 }	120 }
>2 mm fragments	7 (1.4)	85 (17)

Discussion

Early enthusiastic descriptions of PCNL, with reports of high success rates from large series of patients in Europe and the USA between 1980 and 1985, led to increasing numbers of patients being referred to centres which specialised in percutaneous surgery. The surgeons and general practitioners referring these patients had high expectations that this treatment would be successful in removing the stones and result in shorter hospital stays with a more rapid and pain-free convalescence than was expected after open surgery. In addition, complication rates appeared to be low.

The series reported were mainly of patients with

small simple stones eminently suitable for a straightforward lift-out procedure. Less attention was paid, however, to the larger complex stones or the unfit patient that may present with these stones. As PCNL was developing, ESWL was rapidly becoming an accepted and established technique for the treatment of renal stones. Many patients with small simple stones, initially referred for PCNL, were effectively treated by ESWL. The resulting complex stones were proving difficult to treat by PCNL alone and we were disturbed at suggestions that PCNL alone should be effective in the majority of cases (Mays *et al.*, 1988). We were also aware that many of our patients and their referring doctors were disappointed that the treatment was often prolonged, complex and unsuccessful. The reasons for this are multifactorial but due mainly to the patients being more unfit and the stone burden greater.

Whilst there is only a small increase in the age of the patients in the later group, there is no doubt that the patients now presenting have a much higher incidence of other medical problems (which may indeed have been the cause of their stones). The presence of these problems obviously necessitates a more rigorous pre-operative preparation and also increases the likelihood of post-operative morbidity and mortality. It is interesting that the presence of solitary or horseshoe kidneys has not been associated with an increase in the number of complications. Gross obesity is a relative contraindication to open surgery and due to imaging failure and machine inadequacy may also be an absolute contraindication to ESWL. Similarly, obesity causes problems with PCNL due to imaging failures and instruments that may be too short to reach the stone or even the kidney.

The stone burden has increased both in size and complexity. This is reflected in the increased need for multiple punctures during a PCNL session, the almost 3-fold increase in patients requiring multiple PCNL sessions and a similar increase in the number of patients requiring *in situ* disintegration by ultrasound or electrohydraulic lithotripsy.

Failed access has become much less of a problem (only 5% in Group 2) and this must be due to increased radiological expertise. Per-operative complications have also decreased as a result of the development of more sophisticated purpose-designed instruments and improved operator expertise. In a centre with a teaching commitment there will inevitably be a learning curve effect on the numbers of such complications. The increase in post-operative complications from 13.6 to 24% is a factor of the need for longer and more complex procedures in often unfit patients.

The reduction in the number of patients rendered stone-free or left with small fragments, from 93 to 65% with PCNL alone, is disappointing but inevitable with increased stone burden and complexity. It is encouraging that with the addition of ureteroscopy, lasertripsy, ESWL and occasionally open surgery, the success rate rises to 83%.

This study confirms our suspicions that the practice of percutaneous stone surgery is changing and shows that complex stones now being referred and the patients with complex medical problems represent a considerable challenge to urologists, radiologists and their medical colleagues. It is clear that this challenge will inevitably result in higher complication rates and lower success rates than previously reported.

PCNL alone is unlikely to render these patients stone-free and suggestions that it be used in preference to ESWL are clearly spurious. PCNL must be viewed only as part of the management, in conjunction with ESWL and other radiological and endourological techniques.

Acknowledgement

We are grateful to Miss Sarah Read for typing the manuscript.

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The Authors

D. J. Jones, FRCS, formerly Senior Registrar in Urology, St Paul's Hospital. Now Consultant Urologist, The Princess of Wales RAF Hospital, Ely.

G. L. Russell, FRACS, formerly Senior Registrar in Urology and Australasian Fellow, St Paul's Hospital. Now Senior Registrar in Urology, Norfolk and Norwich Hospital, Norwich.

M. J. Kellett, MD, FRCR, Consultant Radiologist, St Paul's Hospital.

J. E. A. Wickham, MS, FRCS, Consultant Urologist, St Paul's Hospital; Director, Academic Unit, Institute of Urology.

Request for reprints to: Wing Commander D. J. Jones, The Princess of Wales RAF Hospital, Ely, Cambs CB6 1DN.